PB-217 247

LABORATORY EXAMINATION OF A RUPTURED 50-mg RADIUM SOURCE

P. H. Bedrosian, et al

Southeastern Radiological Health Laboratory
Montgomery, Alabama

May 1970

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

BRH/SERHL 70-1

PB 217 247

LABORATORY EXAMINATION of a RUPTURED 50-mg RADIUM SOURCE

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service

SOUTHEASTERN RADIOLOGICAL HEALTH LABORATORY

TECHNICAL REPORTS

Technical reports of the Southeastern Radiological Health Laboratory, Bureau of Radiological Health, are available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151. Price is $3.00 for paper copy and $0.65 for microfiche. The PB number, if indicated, should be cited when ordering.

Title	
Radiological Survey of Major California Nuclear Ports - April 1967	PB 178 728
Radiological Survey of Hampton Roads, Virginia - January 1968	AD 683 208

BRH SERHL 70-1

LABORATORY EXAMINATION of a RUPTURED 50-mg RADIUM SOURCE

P. H. Bedrosian
G. L. Gels

SOUTHEASTERN RADIOLOGICAL HEALTH LABORATORY
P.O. BOX 61
Montgomery, Alabama 36101

MAY 1970

Details of illustrations in this document may be better studied on microfiche.

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Environmental Health Service
Bureau of Radiological Health
Rockville, Maryland, 20852

FOREWORD

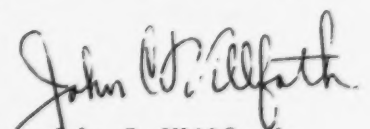
The Bureau of Radiological Health has the responsibility of carrying out a national program designed to reduce the exposure of man to hazardous ionizing and nonionizing radiation.

As one of three regional laboratories within the Bureau of Radiological Health, the Southeastern Radiological Health Laboratory contributes to this program through endeavors in research, applied technology, and training. These include evaluation of electronic product radiation and exposure conditions; development of analytical and radiochemical methodology; application of radiation technology, including radium usage and sealed source testing; and development and presentation of courses on the radiological health aspects of ionizing and nonionizing radiation.

The Bureau publishes its findings in Radiological Health Data and Reports (a monthly publication), the Environmental Health Series, Public Health Service numbered reports, appropriate scientific journals, and Southeastern Radiological Health Laboratory (SERHL) technical reports.

The technical reports of the SERHL allow comprehensive and rapid publishing of the results of intramural and contractor projects. The reports are distributed to State and local radiological health program personnel, Bureau technical staff, Bureau advisory committee members, university radiation safety officers, libraries and information services, industry, hospitals, laboratories, schools, the press, and other interested individuals. These reports are also included in the collections of the Library of Congress and the Clearinghouse for Federal Scientific and Technical Information.

I encourage the readers of these reports to inform the Bureau of any omissions or errors. Your additional comments or requests for further information are also solicited.



John C. Villforth
Director
Bureau of Radiological Health

PREFACE

Generally accepted laboratory procedures and techniques are commonly used in the routine handling of radium as well as in research studies conducted in the Radium Technology Program, Southeastern Radiological Health Laboratory, Bureau of Radiological Health. Frequently, however, modifications of standard procedures or the development of additional methods are required to solve a unique problem related to radium. Because these innovations represent useful practical applications in the prevention of unnecessary radiation exposure and radioactive contamination to personnel, they are documented in this report for use by others.

We hope that the material presented in this report will be helpful in promoting radiation protection to handlers, to users of radioactive materials, and to the general environment.

Charles R. Porter
Director
Southeastern Radiological Health Laboratory

Preceding page blank

CONTENTS

Page

LIST OF ILLUSTRATIONS..... vii

FOREWORD..... iii

PREFACE..... v

ABSTRACT..... vii

INTRODUCTION..... 1

LABORATORY PREPARATION AND PROCEDURE..... 1

Photographing Source..... 4
Measurement of Radium Content..... 8

SUMMARY..... 11

FIGURES

1. Procedure for removing source from drum includes the following steps: (1) attach large polyethylene bag to mouth of drum; (2) detach lid and pass into remote end of bag; (3) tie bag at two positions to form two separate enclosures; (4) sever bag between ties and repeat steps 1, 2, and 3 to remove contents from drum..... 2

2. In this picture, taken by a 35-mm, single lens, reflex camera with a 55-mm lens, slight bending of the encapsulation is evident. The near circumferential rupture (arrow) in the monel casing is visible about 15 mm from the tip of the source. (The white material on the handle is part of the tape used in holding the source in its pig.)..... 5

3. Another view of the source in which the rupture (arrow) can be seen..... 5

4. A 5-second exposure of the ruptured source was made using the shielded photographic leak-testing procedure. The area of rupture is clearly visible and no backlighting was used..... 6

Preceding page blank

Page

5. A 1-second exposure with backlighting orients the rupture with the monel capsule in the shielded photographic leak-test method..... 6

6. Under magnification, the overlapping nature of the circumferential rupture becomes apparent..... 6

7. The buckling nature of the connecting portion of the encapsulation is highlighted at increased magnification..... 7

8. The two parts of the ruptured source are held together in the opened position by the narrow connecting band of monel..... 7

9. Comparison of daily gamma-ray dose measurements during buildup of daughter products in ruptured nasopharyngeal applicator to a nonleaking applicator..... 10

ABSTRACT

A procedure for safely handling a ruptured radium source is described. The technique employed was designed to prevent leakage of radium to the environment and also to minimize radiation exposures to personnel. A photographic leak-test method developed at the Southeastern Radiological Health Laboratory, Bureau of Radiological Health, was also tested with the ruptured source. Measurements and photographic evaluation of the rupture and assessment of radium losses from the source are documented.

Representative products and manufacturers are named for identification only, and listing does not imply endorsement by the Public Health Service and the U.S. Department of Health, Education, and Welfare.

THE AUTHORS

Mr. P. H. Bedrosian is Assistant Director for Environmental Radiation Control at the Southeastern Radiological Health Laboratory, Bureau of Radiological Health, Public Health Service, Environmental Health Service, U.S. Department of Health, Education, and Welfare, P. O. Box 61, Montgomery, Ala. 36101. Mr. G. L. Gels, formerly with the Southeastern Radiological Health Laboratory is presently assigned to the Radiological Engineering Laboratory, Division of Environmental Radiation, Bureau of Radiological Health, Environmental Health Service, USDHEW, 5555 Ridge Avenue, Cincinnati, Ohio 45213.

LABORATORY EXAMINATION OF A RUPTURED 50-mg RADIUM SOURCE

INTRODUCTION

Many leaking and damaged radium sources were studied by the Radium Technology Unit, Southeastern Radiological Health Laboratory (SERHL), Bureau of Radiological Health, in the development of a photographic leak-test method.[1] The largest available leaking source used in this research was a needle containing 20 mg of radium 226. Since experimental data from the study indicated that larger sources could be tested, the Radium Technology Unit was interested in establishing an upper limit for the leak-test method and was, therefore, interested in obtaining a leaking source greater than 20 mg. For this purpose a 50-mg nasopharyngeal applicator, ruptured 4 months previously, was obtained. In sending the applicator to the Southeastern Radiological Health Laboratory, the shipper had placed the source in a lead shield that was placed in a wood crate and wrapped in several layers of plastic sheets before sealing it in a 55-gallon steel drum. Extreme care had been taken in preparing this source for shipment because of its damaged condition.

LABORATORY PREPARATION AND PROCEDURE

The source, undisturbed in the sealed drum, was delivered to the radium laboratory, where no immediate attempt was made to inspect or move the source from the shipping drum. Unsealing the container and removing

---

[1]BEDROSIAN, P. H. Photographic technique for leak testing radium sources. Amer J Roentgen 102:207 (1968).

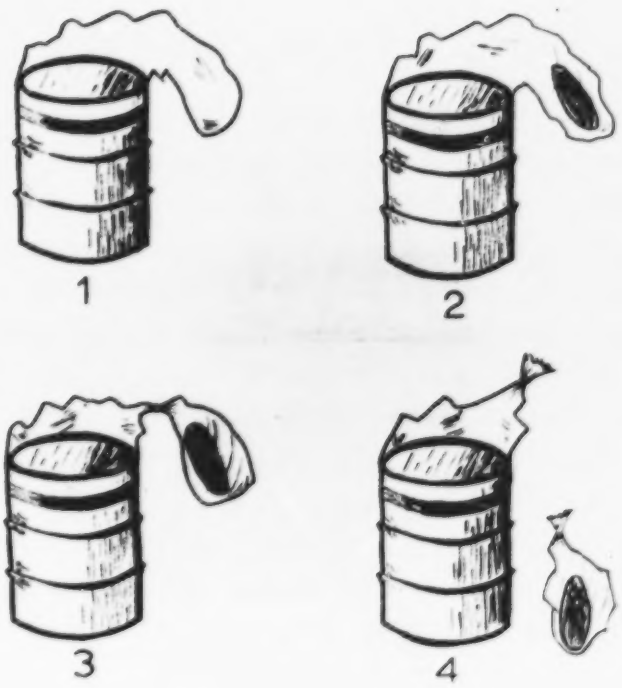


Figure 1. Procedure for removing source from drum includes the following steps: (1) attach large polyethylene bag to mouth of drum; (2) detach lid and pass into remote end of bag; (3) tie bag at two positions to form two separate enclosures; (4) sever bag between ties and repeat steps 1, 2, and 3 to remove contents from drum.

the source from its lead shield could have resulted in gross radium contamination of the drum and immediate laboratory buildings, in addition to the possibility of losing radium from the source. Measurement of the gamma radiation level around the drum indicated exposure doses of approximately 5 mR at 1 meter. Guided by these levels and the realization that the severity of the damage to the source was not fully known, removal operations were performed cautiously and deliberately outside the laboratory in a stepwise manner as follows and as shown in figure 1:

1. A large transparent polyethylene bag was draped over the top of the drum and taped to form a sealed, slightly evacuated air space above the drum.

2. The lid of the drum was removed by passing it into the plastic bag that was tied to form a separate envelope for the lid. This envelope was detached and the cut ends were sealed with tape. No radioactive contaminants were released from the drum, as the drum with its lid removed was sealed by one end of the plastic bag, and the lid sealed in the envelope formed by the opposite end. Through the plastic-covered opening of the drum, the plastic-covered box could be seen inside.

3. Another large plastic bag was draped over the mouth of the drum and taped as before. With a scalpel and large screwdriver placed within the bag before it was taped, the first plastic seal and the plastic sheets covering the crate holding the source were removed within the drum. The wooden crate was taken apart. The lead pig with the source was passed into one end of the large plastic bag. An envelope was formed about the source and shield and, as before, was detached and the source transferred to the radium laboratory. The drum, now containing scraps of plastic, a broken wooden crate, contaminated scalpel and screwdriver, was sealed by the lid which was still in its separate plastic bag.

4. Within the radium laboratory, the source was removed from the pig, through a hole cut in the plastic envelope, and placed behind a lead shield for examination. This shield had been set up beneath a mirror so that the source behind the shield could be seen without unnecessary personnel exposure.

Photographing Source

By viewing the mirror and using a 35-mm, single lens, reflex camera several pictures were taken of the ruptured source in various positions (figs. 2 and 3). The source was then transferred to the shielded photographic leak-test device and examined for radium leaks.[1] Results of this technique are shown in figures 4 and 5. The area of leakage can be seen easily in the photograph (fig. 4). By using a source of light above the applicator, a shadow of the source was superimposed on the image produced by the beta, alpha, and gamma radiations to produce a composite image as shown in figure 5. The leak, as well as the location of the rupture along the source, can be seen readily in the composite photograph.

At the conclusion of the leak-test measurement, the source was extensively photographed behind shielding by use of a stereoscopic microscope fitted with a Polaroid Land camera back attachment. Pictures taken at various magnifications, ranging from 3X to 15X power, clearly delineate the rupture (figs. 6 and 7). During this operation, the encapsulation, which displayed a nearly circumferential rupture, was so weak structurally that it opened as the source was manipulated on the microscope stage. A few visible grains of radium salts spilled from the opening onto the stage. The source was photographed in this new position (fig. 8), then carefully closed, and returned to its lead shield. After the photographic examination, the source in its shield was returned to a 5-liter desiccator and covered.

---

[1]See footnote on page 1.

Figure 2. In this picture, taken by a 35-mm, single lens, reflex camera with a 55-mm lens, slight bending of ıe encapsulation is evident. The near circumferential rupture (arrow) in the monel casing is visible about 15 mm from the tip of the source. (The white material on the handle is part of the tape used in holding the source in its pig.)

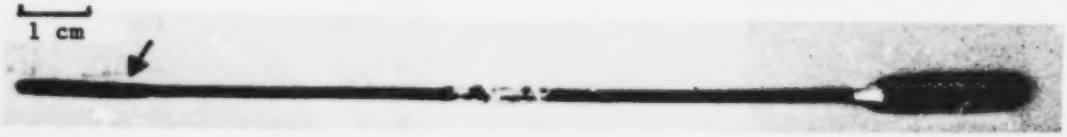


Figure 3. Another view of the source in which the rupture (arrow) can be seen.

Figure 4. A 5-second exposure of the ruptured source was made using the shielded photographic leak-testing procedure. The area of rupture is clearly visible and no backlighting was used.

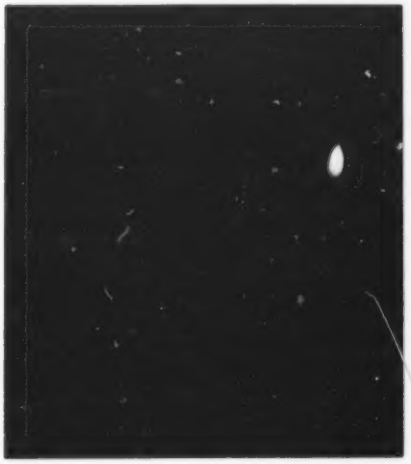


Figure 5. A 1-second exposure with backlighting orients the rupture with the monel capsule in the shielded photographic leak-test method.

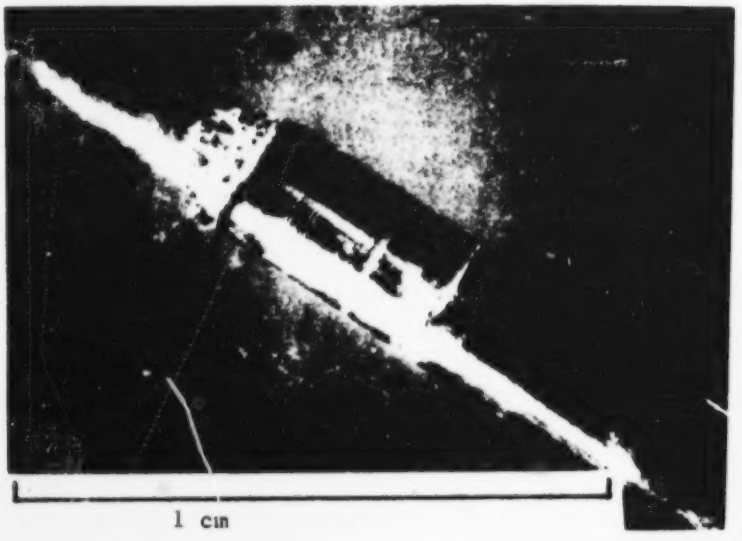


Figure 6. Under magnification, the overlapping nature of the circumferential rupture becomes apparent.

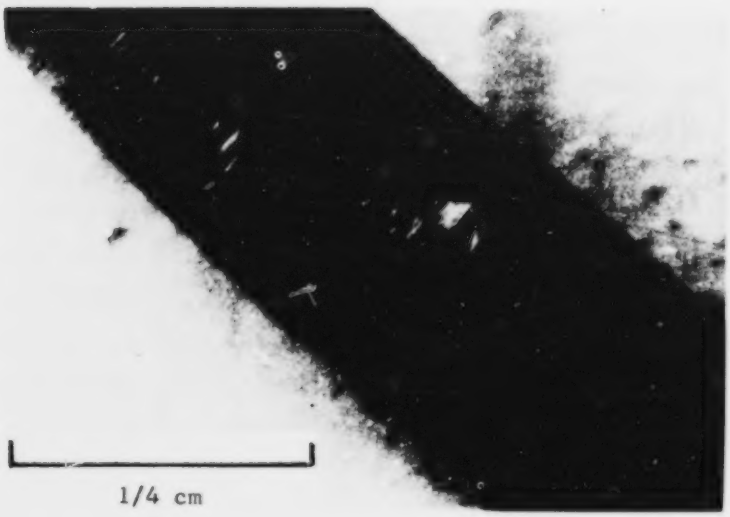


Figure 7. The buckling nature of the connecting portion of the encapsulation is highlighted at increased magnification.

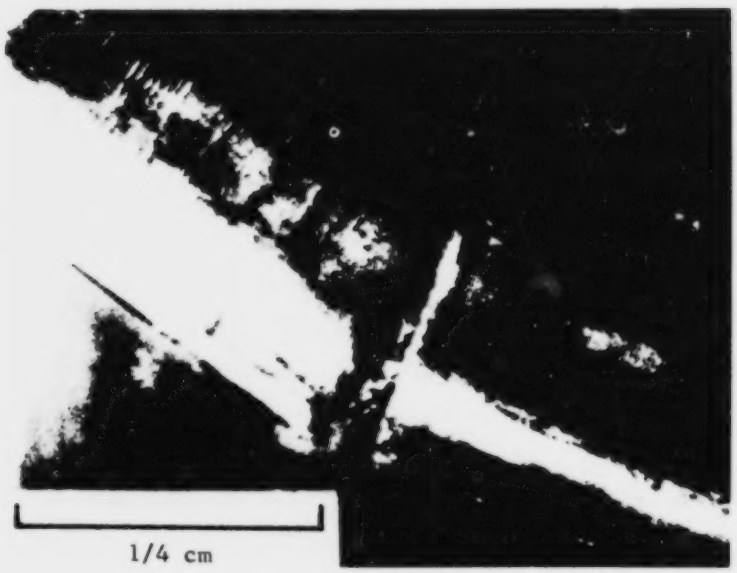


Figure 8. The two parts of the ruptured source are held together in the opened position by the narrow connecting band of monel.

Measurement of Radium Content

Because the source was badly damaged, release of radium to the environment was a likely possibility. To evaluate the radium content of the 50-mg applicator, it was prepared for encapsulation in a 4 cm long glass ampul. Before the radium-bearing capsule (2 cm long) was placed in the ampul, the few grains of material that spilled onto the microscope stage were retrieved by use of short slivers of sticky tape. These grains were placed in the ampul, followed by the source. In order for the capsule portion of the applicator to fit into the ampul, about 13 cm of the handle was cut and removed from the source. Wirecutters were used for this purpose; the source was behind a lead shield. In this operation the capsule was positioned in the ampul and held in place with the wirecutters gripping the source handle. The handle was snipped and the capsule dropped into the ampul which was then sealed by a gas torch. The encapsulated source was leak tested by placing it in a tightly covered jar for 5 days, then the lid was examined for alpha radioactivity. No radioactivity was found on the jar lid, indicating that the encapsulation was effective.

Inasmuch as the method of choice for determining the radium content of the source was to measure the gamma-ray intensity by use of a condenser R-meter, a jig, in which the ampul and a condenser R-meter chamber could be securely oriented, was built using lead and steel bricks. With this device, precise measurements were made of the gamma-ray intensity related to the radium within the ampul.[2] A 49.94-mg radium source, received from a commercial supplier and already sealed in a glass ampul, was used as a standard. It was almost identical in size and shape to the ruptured source. Calculations of the radium content of the ruptured source were based on the relative gamma-ray intensities of the two sources. For 36 days after sealing the source, daily measure-

[2]JOHNS, H. E. The Physics of Radiology, 2d Edition. Charles C. Thomas, Springfield, Ill. (1961), p. 470.

ments of gamma-ray levels were made with both sources. At the end of this time, the gamma-ray flux from the ruptured source had reached more than 99.85 percent of its equilibrium value. This finding corroborates the fact that only a small fraction of the radon produced by radium sulfate is released from the dry salt. In this case, less than 5 percent of the radon escaped from the radium salts, which essentially had been exposed to the atmosphere for more than 4 months before being sealed.

Daily measurement of the gamma dose rates was recorded graphically (fig. 9). For these gamma-ray dose determinations, a Victoreen Model 570 Condenser R-Meter and a Model 552 ionization chamber having a range of 2.5 R were used. Pressure and temperature corrections were applied to all measurements. The uncertainty of measurement in the dose rate from the standard is indicated in the graphs by the long dashed lines. Assuming an equal uncertainty in the readings from the ruptured source, computations indicate 46.2 ± 0.05 mg of radium 226 present in the damaged applicator.

Not all of the radium received at the Laboratory in connection with the leaking source was sealed in the ampul. The lead container in which the ruptured source was transported showed some radium contamination; in addition, some contamination was observed on instruments and other objects coming in contact with the ruptured source in the laboratory. These contaminated items were collected along with contaminants drilled out of the lead container and sealed in a 5-gallon can for 30 days. The gamma radiation from this material was measured in the same manner as the ruptured source and it was demonstrated that approximately 0.1 mg of radium was present as contamination. The 55-gallon steel drum was also examined, but no significant radiation was detected.

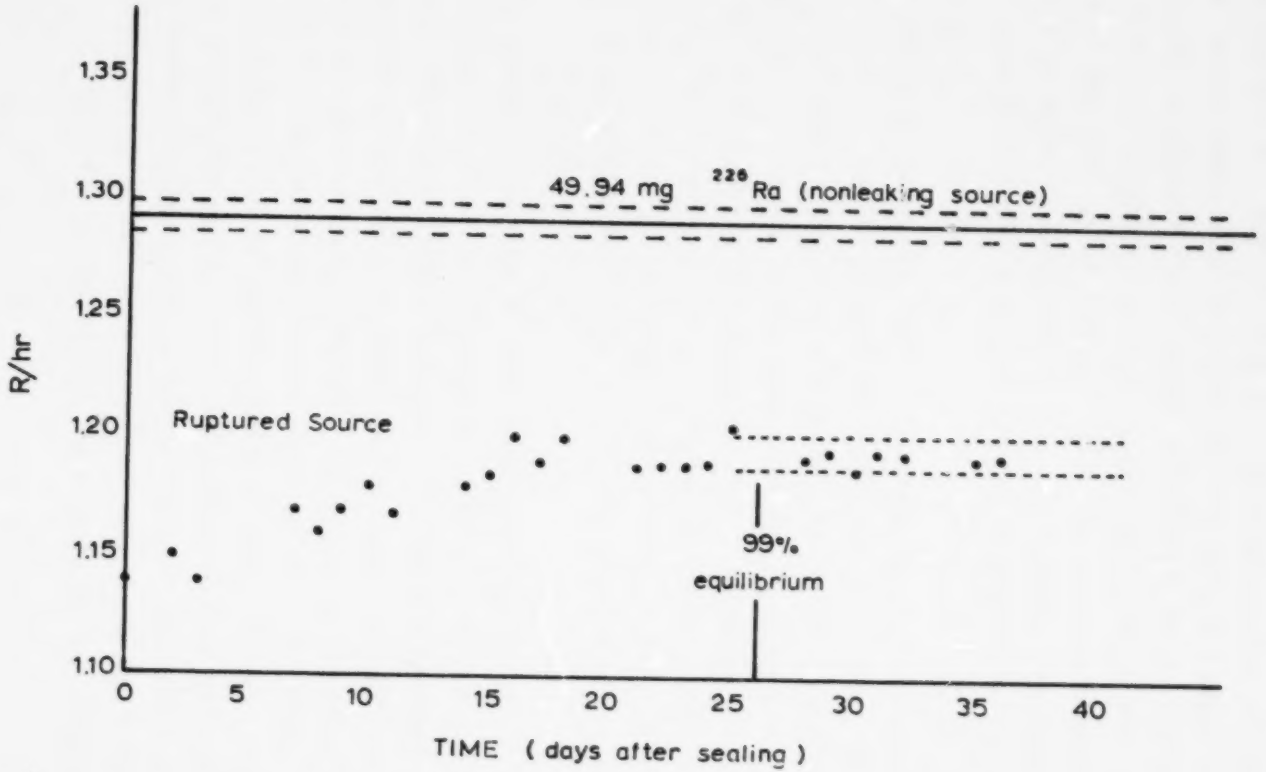


Figure 9. Comparison of daily gamma-ray dose measurements during buildup of daughter products in ruptured nasopharyngeal applicator to a nonleaking applicator.

SUMMARY

The ruptured nasopharyngeal applicator was successfully leak-tested by the photographic technique. The method proved useful in locating the rupture along the source. The amount of radium 226 in the applicator was found to be 46.2 ± 0.5 mg at the 90-percent confidence level from measurements made by comparing its gamma-ray intensity to a known standard. Assuming the ruptured source originally held 50.00 mg of radium, approximately 3.8 mg may be considered as lost. Of this loss, about 0.1 mg can be accounted for in the contamination of the lead storage container, and to a lesser extent, some of the handling apparatus used in examining the source.